UNITED STATES ARMY AVIATION BOARD
Fort Rucker, Alabama

STEBG-AVSB-161.1/63

21 NOV 1962

SUBJECT: [redacted], Project No. AVN [redacted], Confirmatory Test of the KS-61 Photographic System

TO: Commanding General
United States Army Test and Evaluation Command
ATTN: AMSTE-TA
Aberdeen Proving Ground, Maryland

1. AUTHORITY.

a. Directive. Disposition Form, ATDEV-5, MD, Headquarters, USCONARC, 23 March 1962, subject: "KS-61 and KA-30."

b. Purpose. To conduct a confirmatory test of the KS-61 Photographic System to determine whether the deficiencies and shortcomings as reported in the United States Army Aviation Board report of Project No. AVN 161.1 have been corrected.

2. BACKGROUND.

a. In early 1958, the KA-30 camera was selected to fulfill the photographic requirement of the AO-1( ) airplane. The U. S. Army Aviation Board evaluated the KA-30 Camera System installed in an L-20 airplane in 1959 and recommended it be considered suitable for Army use (reference 9b). A camera control system different from that used in the L-20 installation was later developed, and this system, including the KA-30 camera, was then designated the KS-61 Camera System.

b. A modified KA-30 camera was designated the KA-30A, the major modification being a larger drive motor. In 1961, the U. S. Army Aviation Board conducted a confirmatory test of the KA-30A Camera and an evaluation of the KS-61 Photographic System (reference 9d), and found the KS-61 Photographic System unsuitable for Army use as tested with

the existing deficiencies and shortcomings. It was recommended that these deficiencies and shortcomings be corrected and a modified system be provided for confirmatory test. The KS-61 system was type classified Standard A in January 1962 (reference 9f).

c. A KS-61 Photographic System installed in an AO-1C Airplane, incorporating some of the modifications proposed in reference 9d, was received for test on 10 October 1961.

3. DESCRIPTION OF MATERIEL. The KS-61 Camera System consists of the following (items 1 through n are modifications which have been incorporated as a result of previous test, Project No. AVN 161.1):

a. The KA-30A. The KA-30 is a still picture, day-night aerial reconnaissance camera capable of operating in any one of four modes - AUTO REMOTE, PULSE, IMC (Image-Motion Compensation) PULSE, or NITE. The camera consists of a camera body, lens cone, two interchangeable 100-foot film cassettes, associated filters, cases, etc. Two photographic lens cones (three- and six-inch) are available for use with the camera. The film format is 4-1/2 x 4-1/2 inch on five-inch roll film. The camera is controlled remotely and features semi-automatic operations. The major modifications incorporated in the KA-30A were a larger film drive motor and the remote mode selection. Other modifications were included but are minor in nature.

b. The Photo System Unit. The photo system unit is an electronic computer, providing control of the cameras (IMC drive rate, pulse rate, and proper exposure time). With proper inputs this unit should provide the desired 60-percent overlap.

c. The Light Monitor. The light monitor is a photoelectric unit which senses the intensity of light reflected from the terrain beneath the airplane and produces an input to the exposure control proportional to the intensity of the light.

d. Exposure Control Panel. The exposure control knob is used to regulate (manually) the input to the photo system unit based on information from the light monitor.

e. Photo Control Panel. The photo control panel:

(1) Provides the operator with means of:

(a) Energizing the main power circuits of the photo system.

(b) Selecting either pulse or autocycle mode of operation.

(c) Positioning the camera mount and activating the proper camera window door.

(d) Providing velocity-over-height (V/H) inputs to the photo system unit.

(e) Controlling system operation.

(f) Salvoing the flares.

(2) Provides visual indications when:

(a) The system is ready to operate.

(b) The system is operating normally.

(c) The camera is in transition.

(d) A film failure occurs.

(e) Last flare is expended.

(3) Provides a counter readout of exposures and remaining flares.

f. Flare Reset Panel. The flare reset panel provides the capability of resetting either the left or right flare-ejector stepping switches to the first available flare-firing position.

g. Flare-Ejector Pod Assemblies. The flare-ejector pod assemblies eject the flares necessary to illuminate the target area during night photographic missions. A pod is mounted at each wing root on top of the wing. The two pods house 104 flares (52 photoflash cartridges each).

h. Camera Mount. The camera mount provides a means of rotating the camera to either 15-degree left oblique, 30-degree left oblique, vertical, 30-degree right oblique or 15-degree right oblique positions. The mount is suspended on two pivot points and is electrically driven on a concentric gear train to the desired positions.

i. Camera Window Doors. The camera window doors operate when power is applied to the camera system. The door corresponding to the camera mount position opens automatically.

j. Camera Compartment Temperature Control. The camera compartment temperature control automatically maintains a minimum temperature of 90°F. in the camera compartment. Heater outlets are provided to defog the camera windows.

k. Oblique Sights. The oblique sights are optical lenses used in oblique photography to aid in the location of the terrain area which is in the optical center of the camera format.

l. Photo Flight-Line Sight. The photo flight-line sight is essentially a vertical wire used in reference with a sight pointer (similar to the sight on a weapon). Sighting is accomplished by obtaining an imaginary straight line between the target and a selected point along the intended flight path. When the imaginary straight line between the target and the reference point is in line with the vertical wire and pointer, the aircraft will pass over the target within the field of view of the camera. This aids the pilot in taking near-vertical photographs. The sight is located on the pilot's side on top of the instrument deck between the glare shield and the windshield and may be collapsed when not in use. . The device is mounted so that it can be pivoted to either side of zero position and is indexed to eight units on each side of zero.

m. "Day" Velocity-to-Height Optical Scanner System. This altitude groundspeed ratio detector system utilizes an optical scanning

system to obtain a velocity-to-height (height is absolute altitude) ratio and automatically provides inputs into the photographic system. The major components of this velocity-to-height scanner system are:

(1) Scanner-Detector. This light-sensing device senses contrast changes in light reflected from the terrain passing beneath the aircraft and generates an output signal with a variable frequency proportional to the ratio of aircraft groundspeed to altitude.

(2) Scanner Converter. The converter changes the variable frequency signal from the scanner detector into a d.c. voltage, proportional to the aircraft groundspeed-to-altitude ratio, to drive various image-motion-compensation (IMC) controlled components and to set the correct exposure interval in the camera control system.

(3) Velocity-to-Height (V/H) Coupler. The coupler couples the d.c. voltage from the scanner converter to the photo system unit.

n. Observer's Pulse Switch. The pulse switch enables the observer to make a single exposure by momentarily depressing the switch or to take pictures at the camera's maximum cyclic rate by holding the switch down while in "Pulse" or "Pulse IMC" mode. In the night mode, it enables the pilot to override the pulse computer, thereby instantly firing one flare which activates the camera system.

4. TESTS. The KS-61 Photographic System installed in the AO-1C Airplane was operated at various altitudes from 50 to 10,000 feet and indicated airspeeds from 150 to 300 knots. Thirty-three missions were flown during the test period. Testing was directed toward determining whether previously reported deficiencies and shortcomings had been corrected and whether any degradation in performance of the photographic system resulted from the modifications incorporated.

a. The modifications incorporated affected the electrical requirements, weight, and size of the system as follows:

(1) An increase in power requirements which was well within the capacity of the aircraft power system.

(2) A weight increase of 22.5 pounds.

(3) An increase in volume of 0.5 cubic feet. The dimensions of the individual components added in the modification of the KS-61 are listed below:

(a) Velocity-to-height optical scanner system:

1. Scanner detector with mount, size 8 1/4" x 5 13/16" x 4 1/2"

2. Scanner converter, 14 13/16" x 4 3/4" x 6 3/4"

3. Scanner coupler, 2 1/16" x 4 1/8" x 7 15/16"

(b) Photo flight-line tracking device, 6 1/16" x 3/4" x 2"

b. Operational Characteristics. There was no change in operational characteristics except as noted below:

(1) Photo Flight-Line Tracking Device. This device aided the pilot in lining up the aircraft with the target, but he was still unable to determine when the aircraft was directly over the target.

(2) Observer's Pulse Switch. Relocation of the observer's pulse switch to the instrument panel was adequate and compatible with the other components of the KS-61 Photographic System.

(3) "DAY" Velocity-to-Height Optical Scanner System. The "Day" Velocity-to-Height (V/H) optical scanner system was utilized during the testing period to provide V/H inputs to the photo system unit. The scanner system operated satisfactorily throughout the testing period and was compatible with the other components of the KS-61 Photographic System.

c. Tactical Suitability. The use of the "Day" velocity-to-height scanner when operating in the scanning mode relieves the operator from having to determine the ground speed and absolute altitude and eliminates the need to set these values manually into the system. However, the means to permit the pilot to accurately position the aircraft vertically over a target is still lacking.

d. Personnel.

(1) Operating personnel required only brief oral instructions on the use of the photo flight-line tracking device and "DAY" velocity-to-height optical scanner system.

(2) The addition of the photo flight-line sight and the V/H scanner to the KS-61 Camera System increases the on-the-job training program approximately five minutes. The total training now requires approximately five hours classroom instruction and three hours and five minutes on-the-job training.

e. Maintenance. No change in maintenance requirements was experienced as a result of the modifications.

5. FINDINGS.

a. The status of the deficiencies and shortcomings reported in the confirmatory test of the KA-30A Camera (reference 9d) is as follows:

(1) Deficiencies.

Deficiency Previous Test	Findings This Test
Oblique sights were inadequate.	Deficiency still exists.
Vertical sight or viewfinder was not provided.	Deficiency still exists. A photo flight-line tracking device was provided but was not capable of assuring the pilot of accurate positioning of the airplane for vertical photography.

(2) Shortcomings.

Shortcomings Previous Test	Findings This Test
Location of observer's pulse switch was unsatisfactory.	Shortcoming was corrected. Observer's pulse switch was relocated on the observer's instrument panel.
No camera compartment lighting was provided.	Shortcoming still exists.
V/H scanner was not provided.	Shortcoming was corrected.
Camera control did not permit full utilization of the camera's capability (switching from Day-Night or IMC Pulse-Pulse mode of operation in flight).	Shortcoming still exists.

b. No additional deficiencies or shortcomings were discovered during this test.

6. DISCUSSION.

a. The KA-30A Camera previously tested was manufactured by Chicago Aerial Industries. However, production cameras are being built by Viewlex Corporation. The US Army Aviation Board submitted a requisition on 6 April 1962 for a KA-30A Camera, manufactured by Viewlex Corporation. This was to permit an evaluation of the production Viewlex camera concurrently with the evaluation of the KS-61 system. Despite numerous attempts to obtain a production model, (the latest attempt being a message to CG, US Army Materiel Command, with an information copy to CG, USATEC, on 4 October 1962, reference m) the Viewlex camera has not been made available to this Board for testing.

b. Several problems were encountered during the confirmatory test of the KA-30A and during the evaluation of the KS-61 Camera System, Project No. AVN 161.1 (reference d). Some of these problems were:

(1) True vertical photography at intermediate and high altitude was extremely difficult because of the absence of a vertical viewfinder..

(2) One individual cannot operate the camera system over its operating range since an observer is required when taking right oblique photographs.

(3) Left oblique photography required the pilot to direct his attention 90 degrees from the flight path, causing extreme hazard when flying at 50-500 feet altitude.

(4) Rapid positioning of the camera from vertical to oblique or oblique to vertical could not be accomplished. Repositioning of the camera may be required to obtain satisfactory results on a single flight pass over a target.

(5) When an error has been determined in the flight path to the target, considerable maneuvering is usually required just prior to reaching the target in order to position the aircraft for the desired photographic coverage. This error cannot be compensated for by the camera coverage because of the limited coverage at low altitude.

(6) Targets of opportunity cannot normally be photographed without having to maneuver for a second pass.

(7) The light monitor requires constant attention to insure proper exposure.

(8) The camera mode of operation must be pre-selected on the ground since the mode selector switch is located on the photo system unit and is not accessible from the cockpit. This is of particular significance when a day flight may extend into the night and a requirement for night photography develops.

(9) The loading of the film into the camera, when the camera is installed in the aircraft, was difficult due to space restriction within the camera bay and the lack of camera bay lighting.

c. The US Army Signal Avionics Field Office estimates a cost of $80,000 and a period of 20 months for the development, procurement, prototype installation, and testing of a vertical viewfinder (reference e). The development and testing of an oblique viewfinder are estimated to cost $200,000 and will require 18 to 24 months.

d. The US Army Aviation Board concluded that a tri-camera (70mm format) photo system offered potential solutions to the problems cited above. In early 1962 the US Army Aviation Board initiated a test program employing a locally fabricated system to determine what advantages, if any, may be realized when using a tri-camera photo system (reference g). The results of this evaluation indicated:

(1) Greater operational versatility.

(a) Panoramic-type photographic coverage may alleviate the need for both the vertical and oblique viewfinders.

(b) All cameras may be operated simultaneously or individually to insure adequate target coverage on a single camera run.

(c) Targets of opportunity can be photographed with a minimum of preplanning and maneuvering because the three cameras are installed so as to provide near horizon-to-horizon photographic coverage.

(d) The near horizon-to-horizon photographic coverage available even at low altitude permits satisfactory photographs to be obtained with the tri-camera system even though the aircraft is not positioned on the desired flight path. The use of the KS-61 Photo System, however, which has a more narrow field of view, would normally result in an unsuccessful mission.

(2) Greater reliability.

(a) Loss of one camera does not necessarily mean loss of camera capability.

(b) Image-motion computations are not necessary when high shutter speeds are employed, thus simplifying the system.

(3) Reduced operator requirements because of system simplicity.

(4) A substantial savings in size, weight, and number of components would be realized.

e. Based upon the results obtained from the tri-camera evaluation, Headquarters, USCONARC, made the following recommendations in a letter (reference h) to the Chief of Research and Development. (The current status of these recommendations is unknown to the US Army Aviation Board.)

(1) "A fan-of-three camera system be developed using off-the-shelf 70mm cameras and correcting the inadequacies noted in the inclosed report. It is not intended that this recommendation precipitate an expensive or long-range development effort. The concept is considered well worth pursuing and is believed to involve minimal costs. As in-house development should be considered."

(2) "Close and continuing coordination be effected by the developer with the US Army Aviation Board and the US Army Intelligence Board. The services of the Aviation Board for consultation and to flight test periodically during development without publishing formal reports is offered and is considered desirable."

f. Available information indicates there are several 70mm photographic systems that can be quickly adapted for installation in the AO-1( ) airplane. The selection of these systems for immediate evaluation would provide a minimum delay in continuing the effort to obtain a more suitable photographic system for immediate Army use.

7. CONCLUSIONS.

a. Deficiencies and shortcomings previously reported have not been corrected in their entirety.

b. The KS-61 Photographic System, as tested, is still unsuitable for Army use with the existing deficiencies and shortcomings.

c. Conclusions and recommendations, Project No. AVN 1762, "Evaluation of a Tri-Camera (70mm) Photographic System, reference g, are reaffirmed.

d. The requirement to conduct a confirmatory test on a production model Viewlex KA-30A should no longer be considered.

8. RECOMMENDATIONS. It is recommended that:

a. Lighting be provided within the camera compartment.

b. The KS-61 Photographic System be type classified Standard B.

c. The requirement to conduct a confirmatory test on a production model Viewlex KA-30A be withdrawn.

d. The procurement of a 70mm camera system for evaluation for use in the AO-1( ) airplane be expedited.

9. REFERENCES.

a. Plan of Test, Project No. AVN 859, "Evaluation of the KA-30 Camera System," US Army Aviation Board, 25 June 1959.

b. Report of Test, Project No. AVN 859, "Evaluation of the KA-30 Camera System," US Army Aviation Board, 25 September 1959.

c. Plan of Test, Project No. AVN 161, "Service Test of the AO-1( ) Airplane," US Army Aviation Board, 10 November 1961.

d. Report of Test, Project No. AVN 161.1, "Confirmatory Test of the KA-30A Camera in the AO-1A Airplane," US Army Aviation Board, 8 June 1961.

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e. Letter, TCMAC EAO-1, US Army Transportation Materiel Command, 22 December 1961, subject: "Oblique Camera Sighting System for the AO-1 MOHAWK Aircraft," with one inclosure and 1st Indorsement thereto.

f. Signal Corps Technical Committee Meeting No. 625, dated 29 January 1962, Item No. 5673.

g. Report of Test, Project No. AVN 1762, "Evaluation of a Tri-Camera (70mm) Photographic System," US Army Aviation Board, 4 May 1962.

h. Letter, ATDEV-5 413.5, Headquarters, USCONARC, 5 June 1962, subject: "Evaluation of a 70mm Aerial Camera System."

i. TM 11-6720-208-12, "Operators and Organizational Maintenance Manual, Camera Still Picture, KA-30A and Lens Cone Group LA-136A."

k. TM 11-6720-208-35, "Field and Depot Maintenance Manual, Still Picture KA-30A and Lens Cone Group LA-136."

l. Report of Test, Project No. AVN 161.4, "Service Test of the AN/UAS-4 Infrared Surveillance System Installed in an AO-1C Airplane," US Army Aviation Board, 21 September 1962.

m. Message, STEBG-AVSB 10-18, US Army Aviation Board, 4 October 1962.

n. Letter, STEBG-AVSB, US Army Aviation Board, 10 October 1962, subject: "Evaluation of the Computing Devices of Canada Mohawk/L-19 Photo Reconnaissance System."

A. J. RANKIN
Colonel, Armor
President

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